International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-8, Issue-9; Sep, 2021
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.89.13

Histological description of fresh, cooked and frozen cassava flesh

Priscila Gonzales Figueiredo[1], Astride Stéphanie Mouafi Djabou[2], Adalton Mazetti Fernandes[3], Samuel Carvalho de Aragão[1], Marcio Teixeira Oliveira[4]

[1]Federal Institute of Education, Science and Technology of Mato Grosso do Sul – Naviraí, Mato Grosso do Sul, Brazil.
[2]University of Dschang, Faculty of Agronomy and Agricultural Science, Department of Plant Production, Dschang, Cameroon.
[3]São Paulo State University – Centro de Raízes e Amidos Tropicais – Botucatu São Paulo, Brazil
[4]Federal Institute of Education, Science and Technology of Mato Grosso do Sul – Três Lagoas, Mato Grosso do Sul, Brazil.

Received: 06 Aug 2021,

Received in revised form: 03 Sep 2021,

Accepted: 12 Sep 2021,

Available online: 19 Sep 2021

©2021 The Author(s). Published by AI Publication. This is an open access article under the CC BY license (https://creativecommons.org/licenses/by/4.0/).

***Keywords*— Manihot esculenta, cell, light microscopy, texture.**

***Abstract*—** *The aim of this study was to describe the histological feature of cassava flesh at harvest, after cooking and after freezing. A light optical microscopy was used to analyze the relevant aspects of cassava flesh at these statuses. The non-uniform aspect of cooked cassava is associated with the partial dissolution of the middle lamella and the large amount of non-collapsed cells, while the formation of numerous spaces between cells determines the spongy aspect of cassava after freezing. These data increase the knowledge about cassava post harvest and its processing.*

I. INTRODUCTION

In many countries of Africa, Latin America and the Caribbean, cassava (*Manihot esculenta* Crantz) storage roots are mainly consumed just boiled [1]. Sweet cassava is normally cultivated for this propose and the consumer acceptability is based on the final texture (mealiness) and a low time of cooking [2].

In order to guarantee a high quality or large shelf life of boiled or processed cassava - peeled, frozen and precooked, different approaches are necessary. [3]; [4] and [5] suggested the after cooking quality is related to de tissue condition, what is dependent of storage and time conditions, age of the plant as well as cell and tissue composition. However, [6] suggested the interaction between the components of the tubers and the structural make-up of the tuber tissues [7] play a more important role than the physicochemical and functional properties

Thus, studies regarding the comparison of cassava texture at harvest, after cooking and after freezing increase our knowledge about cassava texture and can bring light for different processing process. The current study aimed to describe the histological status of cassava flesh at harvest, after cooking and after freezing.

II. METHODOLOGY

Seven months old cassava storage root of IAC 576-70 genotype were harvested manually at the experimental field of the College – (Further information will be provide after review process). The IAC 576-70 genotype is a sweet cassava largely cultivated and eaten in Brazil [7].

At harvest time, six roots from different plants were harvested and their middle parts were used for sample preparation and posterior microscopy observation. The roots were washed, peeled and sliced into small pieces of 0.05 m. samples were classified into three categories namely raw, cooked and frozen.

Samples were classified into raw, cooked and frozen cassava. Raw cassava comprised of the flesh of freshly harvested roots. For cooked cassava, the 0.05 m pieces were cooked in water at 85 ^{o}C for 30 minutes according to [8] and afterwards, sample was cooled at room temperature. Frozen cassava was obtained by packaging part of the 0.05 m cassava pieces in a plastic bag in a freezer at -20^{o}C for 24 hours.

After having the raw, cooked and frozen samples, they were prepared for the histological analysis. Sample preparation for histological analysis was previously fixed in a medium constituted by 50 % ethanol: 10 % formalin: 5 % acetic acid for 48 hours and stored in 70 % ethanol until used [9]. After at least 2 weeks they were dehydrated with gradual alcohol concentrations according to [9] and embedded in historesin [10] (Leica® Germany) .

The resulting blocks were sectioned at 8 µm thickness with a microtome (Leica RM 2025; Leica®, Germany). The sections were stained with 0.05 % toluidine blue at pH of 4.7 according to [11] and mounted on slides with Entellan (Merck Millipore®, Germany). The relevant aspects from the various sections were observed under a light microscope (Zeiss®, Inc., NY, USA) and the images were taken by a digital camera (Olympus®, Japan), connected to a microscope (Zeiss®, Inc., Thornwood, NY, USA).

III. RESULTS AND DISCUSSION

Fresh cassava flesh is mainly constituted by parenchyma cells with primary cell wall with different thickness. Lignified cells were represented by the vessel elements, dispersed among the modified xylem and ranged inside the axial and radial ray (Figure 1). Cassava flesh is a modified secondary xylem adapted to store carbohydrates as starch grains. This tissue comes from the activity of the vascular cambium during secondary growth or the growth in thickness of the roots. Cassava flesh is composed of parenchyma cells, few vessel elements and fiber, all these cells differ quantitatively depending on the stage of development of the root [7].

As shown in Figure 1, the fiber content of cassava flesh is composed of cell wall substances and cannot be considered as a fiber in the anatomical sense. According to [12], the fiber present in cassava is mainly composed of cellulose, hemicellulose and pectin, and their amount vary according to the morphological part of the flesh, the age and the environmental conditions. [7] have shown that the fiber cells only exist in the region of the central cord, and fiber cells and vessel elements are the only cells with secondary walls – have lignin in their composition, representing only 5-10 % of cassava flesh.

After the cooking process, the flesh presented a non-uniform aspect (Figure 2), with intercellular spaces. The increase of intercellular spaces is attributed to the gelatinization of pectin [13], which is a component of the middle lamella and parenchyma cell wall [12]. Few parenchymatous cells collapsed and no starch granules were observed inside the parenchyma cells (Figure 2C). The absence of starch granules inside the parenchymatous cell shows the effect of temperature in the starch, and that the cell wall is not a physical barrier for the starch gelatinization.

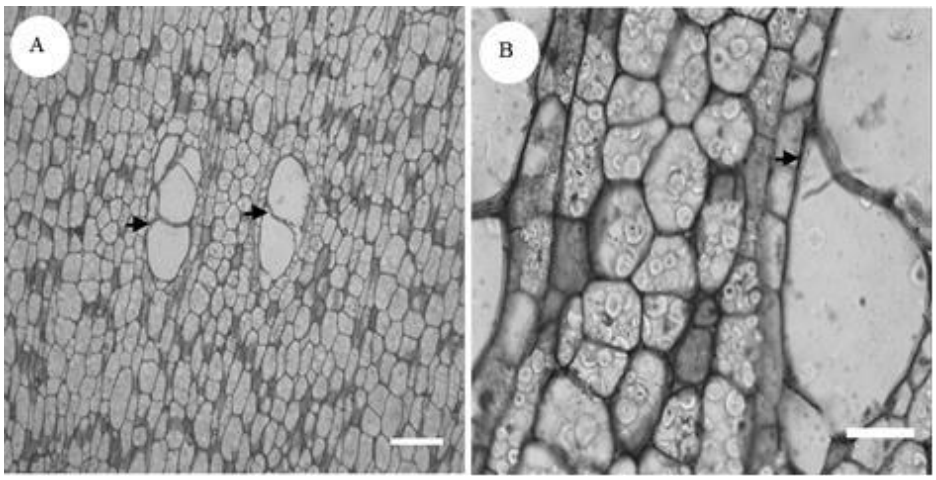

Fig.1: Cross sections of fresh cassava flash. A. Secondary xylem with parenchyma cells and vessel elements, scale bar = 150 mµ and B. Detail of A., showing starch granules, the presence of primary cell wall thicknesses and the presence of lignin only in the vessel element cell wall (arrow), scale bar = 50 mµ.

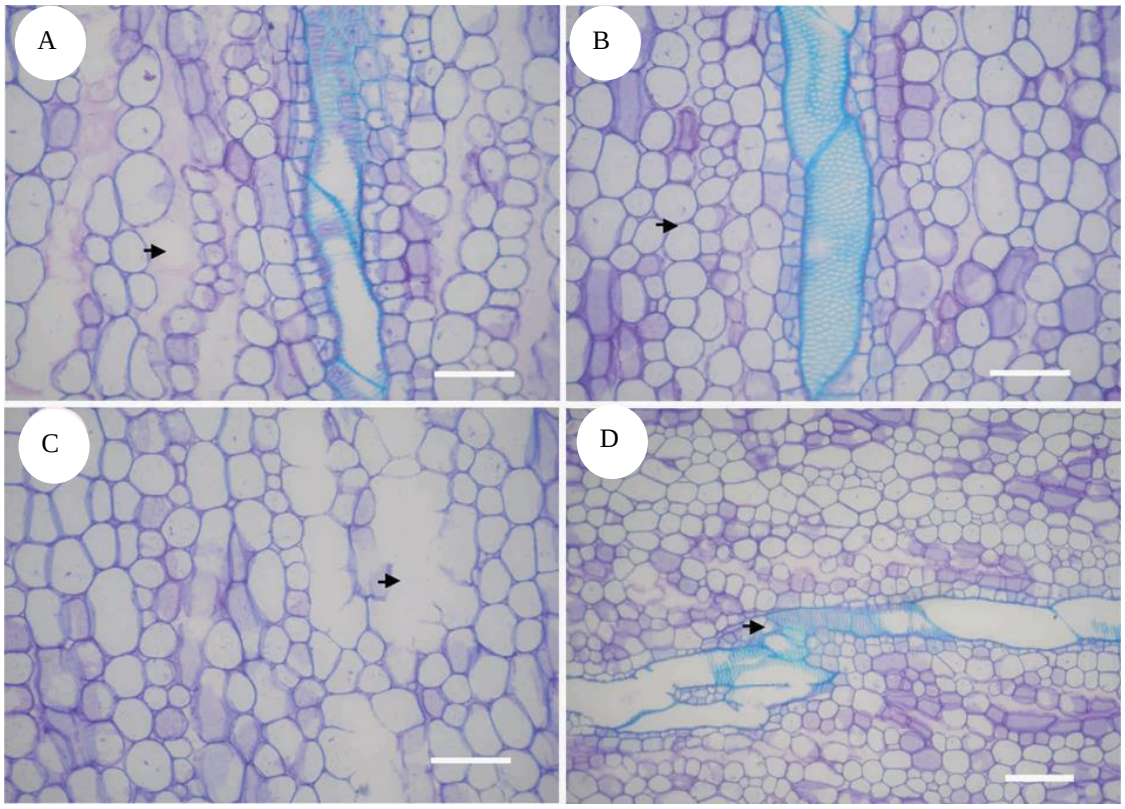

Fig.2: Cross sections of cassava flash after cooking. A and B longitudinal section (A. arrow showing flesh with non-collapsed area; B. arrow showing spaces caused by the dissolution of the middle lamella); C. Transversal section (arrow showing collapsed cells); D. Radial section (arrow showing vessel elements). Scale bar = 100 mμ.

The chemical composition of pectin present in the middle lamella and cell wall is different [5]. The pectin of the middle lamella confers cell adhesion; it acts as cementing agent giving shape, firmness and strength to the cells. This property of pectin may be correlated to the non-uniform texture of the flesh after cooking. [4] has shown that the mealiness of cooked potato (*Solanum tuberosum* L.) is determined by the chemical composition of the cell wall. The results obtained in our study support the observation of [4], since cooked cassava flesh has presented a complete starch gelatinization, while major parenchyma cell wall remained intact.

After the freezing process, cassava flesh presented a spongy aspect. The microscopy observation showed the presence of many opening spaces between the cells (Figure 3) and the presence of plasmolyzed cells. The spongy aspect of the flesh after freezing may be explained by the dehydration process caused by the formation of ice crystals in the intercellular region [14]. According to [15], during freezing the formation of ice occurs firstly inside the intercellular region because of the lower concentration of dissolved solutes. The presence of ice in this region induces a vapor pressure gradient between the inside and the outside of the cell, inducing some water flow inside the cells, promoting the increase of the ice crystals and consequently the separation of the cell walls.

A similar phenomenon was observed in green bean by [3]. He observed that the damage rate of parenchyma tissue decreased with the increase of freezing rates. The increase of the size of crystals induces a pressure on the cell wall and membranes and subsequently breaks them. The decrease of the available water inside the cell because of ice formation induces an increase in the concentration of solute inside the cell, decreasing the freezing point and subsequently the formation of crystals within the cell [3]. The increase of the solute concentration inside the cell as well as the spaces formed among the parenchyma cells because of ice may certainly contribute to the decrease in cooking time as previously observed by [16].

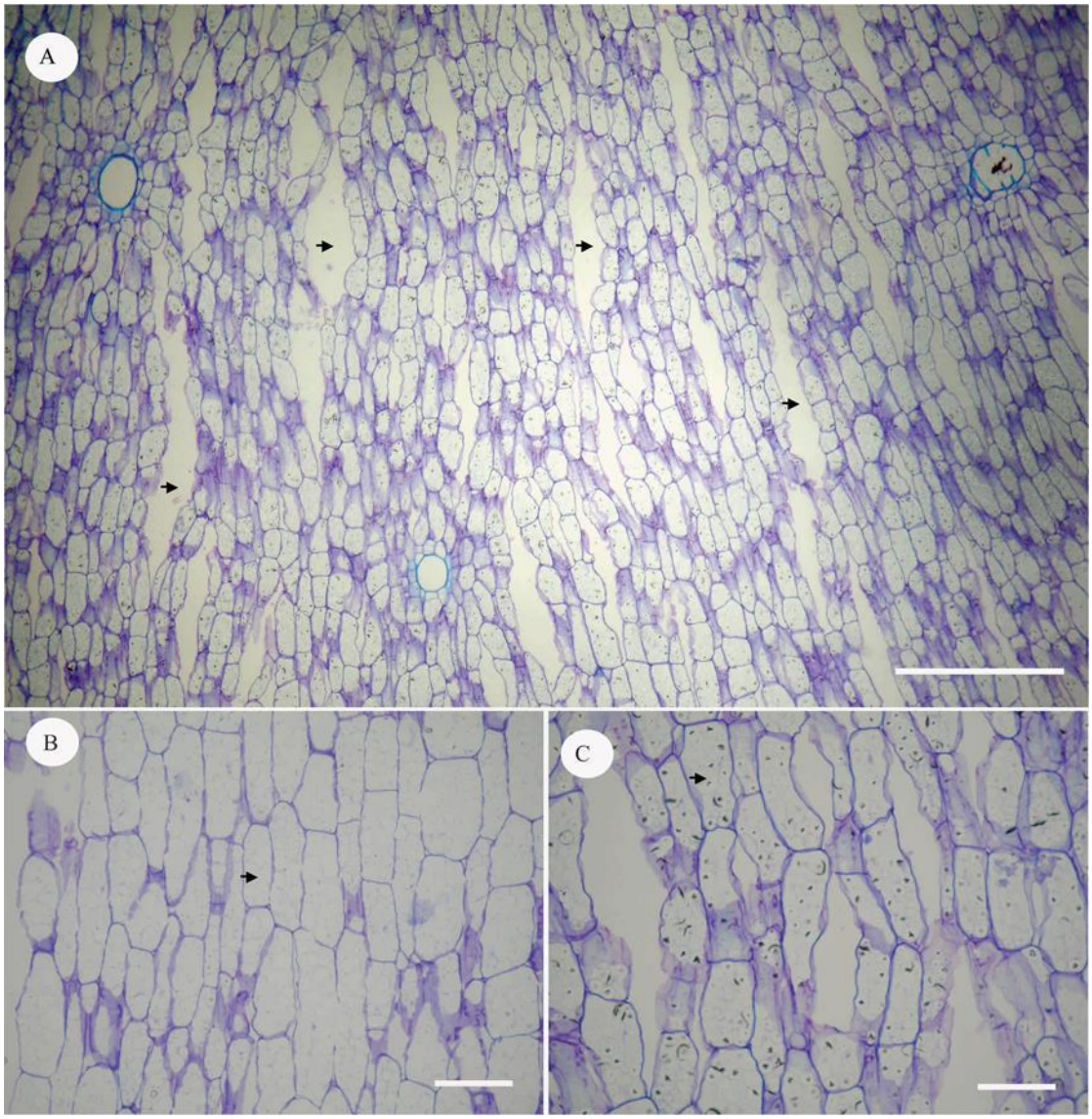

Fig.3: Cross sections of cassava flash after freezing. A. Reserve tissue with numerous gaps between cells (black arrows), scale bar = 500 mμ; B. Intact parenchyma cells (black arrow); C. Plasmolysed cells filled with starch grains (black arrow), scale bar = 100 mμ

IV. CONCLUSIONS

The non-uniform aspect of cooked cassava is associated with the partial dissolution of the middle lamella and the large amount of non-collapsed cells, while the formation of numerous spaces between cells determines the spongy aspect of cassava after freezing.

REFERENCES

[1] Franck H, Christian M, Noël A, Brigitte P, Joseph HD, Cornet D & Mathurin NC (2011) Effects of cultivar and harvesting conditions (age season) on the texture and taste of boiled cassava root. Food Chemestry, 126: 127-133.

[2] Beleia B, Yamashita F, Moraes SR, Silveira CA & Miranda LA (2004) Textural changes during cooking of cassava (*Manihot esculenta* Crantz) roots. Journal of the Science of Food and Agriculture, 84: 1975-1978.

[3] Brown MF (1967) Texture of frozen vegetables: Effect of freezing rate on green beans. Journal of the Science of Food and Agriculture, 18: 77-81.

[4] Nonaka M (1980) The textural quality of cooked potatoes: I. The relationship of cooking time to the separation and rupture of potato cells. American journal of potato research, 57: 141-147.

[5] Paiva EP, Lima MS & Paixão JA (2009) Pectina: propriedades químicas e importância sobre a estrutura da parede celular de frutos durante o processo de maturação. Revista iberoamericana de polímero, 10: 196-211.

[6] Sajeev MS, Sreekumar JS, Moorthy SN, Suj G & Shanavas S (2008) Texture analysis of raw and cooked tubers of short-duration lines of cassava by multivariate and fractional

conversion techniques. Journal of the science of the food and agriculture, 8: 569-580.

[7] Figueiredo PG, Moraes-Dallaqua MA, Bicudo SJ, Tanamati FY & Aguiar EB (2015) Development of Tuberous Cassava Roots under Different Tillage Systems: Descriptive Anatomy. Plant Production Science, 18(3): 241-245

[8] Oliveira MA, Leonel M, Cabello C, Cereda MP & Janes DA (2005) Metodologia para avaliação do tempo de cozimento e características tecnológicas associadas em diferentes cultivares de mandioca. Ciência e agrotecnologia, 29: 126-133.

[9] Ruzin SE (1999) Plant microtechnique and microscopy. Oxford, Oxford University Press.

[10] Gerrits PO (1964) The application of glycol metacrylate in histotechnology: some fundamental principles. Groningen, Leica GmbH. 80p.

[11] O'brien TP, Feder N, Mccully ME (1964) Polychromatic staining of plant cell walls by toluidine blue O. Protoplasma, 59: 368-373.

[12] Pereira LTP & Beleia AP (2004) Isolamento fracionamento e caracterização de paredes. Ciência e tecnologia de alimentos, 24: 59-63.

[13] Menoli AV & Beleia A (2007) Starch and pectin solubilization and texture modification during pre-cooking and cooking of cassava root (*Manihot esculenta* Crantz). Food science technology, 40: 744-747.

[14] Resende JV & Cal-Vidal J (2002) Frutos de melão submetidos a pré-tratamentos com hidrocolóides: efeitos do processo de congelamento sobre a microestrutura celular. Ciência e tecnologia de alimentos, 22: 295-304.

[15] Taiz L & Zeiger E (2012) Plant Physiology. Artmed, Porto Alegre.

[16] Antoniali S, Santos BCN, Nachiluk K (2012) Milho-verde orgânico: produção e pós-colheita. Pesquisa e Tecnologia, 9:1-6.